IMMERSION MEASURING PROBE FOR USE IN MOLTEN METALS

Field Of Invention

The present invention is directed to an immersion measuring probe for measuring a characteristic of molten metal such as temperature and/or oxygen content.

Background

Immersion measuring probes of the general type involved herein are disclosed in a number of prior art patents. For example, see Belgian patents 828,572; 881,886; 884,405; and 889,276. The prior art patents are generally characterized by a measuring head supported at one end of a paperboard tube. The paperboard tube is provided for its insulating protection when the probe is immersed into molten metal.

An oxygen probe supported by a quartz sheath of uniform wall thickness is taught by British Patent 1,094,180. A protective sheath of quartz is objectionable since quartz is transparent to thermal radiation. An oxygen probe supported by a quartz tube partially protected by a tapered graphite sleeve is taught by German Patent 1,928,845. The use of graphite as a protective sleeve is objectionable since it combines with oxygen with the result that the graphite sleeve burns off.

It has been found that the prior art probes of the type involved herein are inaccurate due to several features relating to the manner in which said prior art probes are

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constructed. A large number of solutions involving changes of material as well as changes in construction were investigated. In order to make a satisfactory probe which will give uniform accurate results, it was ascertained that the probe must meet the following criteria:

(a) A considerable reduction of the mass in the vicinity of the measuring was needed to diminish the cooling effect on the metal and thus enable more accurate measurements to be made quicker and at lower temperatures;

(b) When the probe includes a thermocouple, the temperature difference between its cold joints during immersion and temperature meaurement should be reduced;

(c) When the probe includes an oxygen sensor, it should be a solid electro-chemical cell and means should be provided to minimize the influence of oxygen liberated from the oxygen sensor so as to prevent liberated oxygen and other gases from being trapped adjacent to the sensor and thereby giving erroneous readings.

The probe of the present invention is directed to a solution of said problems.

Summary of the Invention

The present invention is directed to an immersion probe which comprises an unit including a support tube which defines the outer periphery of the unit. One end of the tube is an immersion end. At least one measuring element is supported on a measuring head which closes said tube adjacent its immersion end. A connector closes the other end of said tube. Electrical conductors in said tube extend from said connector to said measuring element. Heat insulating material is provided in said tube for protecting said conductors.

A means is provided on the tube for protecting the tube and for minimizing the ability of gasses to be trapped adjacent said measuring element. The means includes a heat insulating refractory sheath telescoped over a major portion of said tube beginning at the immersion of said tube. The sheath tapers toward the

immersion end of the tube with the minimum wall thickness of the sheath being at said immersion end. The tube has an electrical conductive portion projecting beyond the sheath for contact with a bath of molten metal and is electrically coupled to said connector. An elongated hollow support is telescopically coupled to the other end of the tube for supporting the tube and the sheath during immersion into a bath of molten metal.

For the purpose of illustrating the invention, there is shown in the drawing, a form which is presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

The drawing illustrates a longitudinal sectional view of the probe.

Detailed Description

The measuring probe includes a preassembled unit with the outer periphery of such unit being defined by a cylindrical tube 1. The tube 1 is preferably a metal tube made from a material such as low carbon steel. The immersion end 3 of the probe is sealed by a plug of refractory heat resistant material such as cement. Plug 4 constitutes a measuring head for supporting one or more measuring elements. As illustrated, the measuring head supports the thermocouple 5 partially disposed within the quartz tube coated with aluminum oxide and a solid electrolite electro-chemical oxygen sensing cell 6.

The cold joints 7 of the thermocouple are embedded in a gas tight enclosure such as a body of silicone 8 surrounded by a small plastic casing 9. The conductors at the cold joints 7 are V-shaped with the apexes adjacent one another but electrically insulated from one another by the silicone 8. The bottom wall of the casing 9 may be separable and defined by a plastic disk 8A. The tube 1 is filled with a heat insulating material free from crystal water such as resin coated molding sand 10 packed loosely so as to be gas permeable and through which conductors 11

and 12 pass. Conductors 11 and 12 extend from the cold joints 7 to a connector 17. Connector 17 has an electrically conductive sleeve 13 in intimate contact with the electrically conductive tube 1. An electrical conductor 6A extends between the oxygen sensor 6 and one of the cold joints 7. Tube 1 acts as a conductor for closing the circuit of the cell 6.

A heat insulating refractory sheath 2 is telescoped over the major length of the tube 1 beginning at the immersion end 3. The sheath 2 is supported by the tube 1 and is bonded thereto in any convenient manner. Sheath 2 is tapered along a major portion of its length toward the immersion end 3 for protecting the tube 1 and for minimizing the ability of gasses to be trapped adjacent the measuring elements 5 and 6. Sheath 2 is preferably made from a refractory material such as resin coated molding sand. Sheath 2 could be made from other materials such as aluminum oxide or zirconium oxide but should not be made from quartz or graphite.

In order that the tube 1 may perform the additional function of completing the circuit for the oxygen sensor 6, it projects beyond the immersion end of the sheath 2 so that it may contact the molten bath after the protective cap 15 is consumed by the bath as the probe is inserted through a layer of slag. To facilitate immersing the probe into molten metal, a support is provided in the form of a paperboard tube 16 which is force-fit over the tube 1. Adjacent ends of the sheath 2 and support 16 are in contact with one another.

The preferred dimensions for the sheath 2 are by way of example: a length of 10 centimeters, an external diameter of 2.5 centimeters at the immersion end 3, maximum external diameter of 3.7 to 4.8 centimeters; and an internal diameter of about 1.8 centimeters.

In addition to increased accuracy, the probe of the present invention has other advantages: small mass of materials in the vicinity of the measuring elements, excellent protection of the cold joints against mutual temperature differences, a favorable shape for causing the probe to penetrate the bath, etc. Other advantages include the ability to preassemble the probe on a production line basis. In this regard, the electrically conductive tube 1 performs the dual function of providing support for elements therewithin which may be preassembled as a unit and then joined to the sheath 2 and support 16 in an economical manner requiring little or no skill on the part of the workers.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specifications, as indicating the scope of the invention.

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